Preventing Infections in Extensor Mechanism Reconstruction: Best Practices with Synthetic Meshes

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INTRODUCTION:

Extensor mechanism deficiency poses a significant challenge in total knee arthroplasty, and the use of synthetic mesh has provided a reasonable solution for this complex issue. However, synthetic meshes come with their own set of challenges, particularly the risk of serving as a substrate for biofilm formation, which can lead to postoperative infections. These infections can severely impact patient outcomes, leading to increased morbidity and healthcare costs. Therefore, it is crucial to develop innovative strategies to minimize bacterial colonization and infection. This study investigates the efficacy of various infection prevention strategies applied to polypropylene meshes(Marlex), comparing standard meshes with those modified either by antibiotic-loaded calcium sulfate (CaSO4) beads or by direct antibiotic embedding.

METHODS:

The tested groups included a polypropylene mesh (Marlex), polypropylene with antibiotic loaded calcium sulfate beads (Marlex), and an antibiotic embedded polypropylene mesh (Ariste). Each mesh was prepared in their clinical configuration by folding it in upon itself and securing with a running locking stitch. Each construct was then cut lengthwise into five 25mm sections and housed inside 6-well plates. $CaSO_4$ beads were prepared by mixing 20g of $CaSO_4$, 1g vancomycin, and 6ml of saline. The mixture was pushed into a form to mold 3mm diameter spheres weighing 0.05g each. A total of six beads were placed inside the inner folds of each mesh section (n=5). The antibiotic mesh was embedded with minocycline and rifampin by the manufacturer (Ariste)(n=5).Each mesh set was inoculated with $4.8x10^7$ *Staphylococcus aureus* and incubated for five days. After incubation, the meshes were rinsed in PBS, sonicated, and vortexed in Dey-Engley neutralizing broth to detach any bacteria cells. The suspensions were serially diluted and plated for colony counting. Prior to sonication, five of the ten plain polypropylene mesh samples were treated with a PVP-I solution for three minutes. The remaining five plain mesh samples served as controls for calculation and comparison.

RESULTS:

The plain polypropylene group had an average bacterial population of $2.5x10^8$ (range: $6x10^7$ – $7.9x10^8$). SEM imaging showed attachment occurred on both the mesh and suture (Figure 1). After treating with PVP-I, there was a 96.8% reduction. The mesh loaded $CaSO_4$ group had minimal bacteria attachment (261 average; range: 0 – $1.1x10^3$) while the embedded mesh group had no bacteria attachment. When comparing the groups in terms of log reduction, the loaded $CaSO_4$ and embedded mesh groups were both significantly different than the iodine washed group ($p< 0.001$, $p< 0.001$), but not when comparing each other ($p= 0.107$) (Figure 2).

DISCUSSION AND CONCLUSION:

The results of this study demonstrate that both antibiotic-loaded and antibiotic-embedded polypropylene meshes significantly reduce bacterial colonization compared to standard polypropylene meshes treated with PVP-I. Particularly, meshes with embedded antibiotics showed the highest efficacy in preventing bacterial attachment, suggesting that this method could be the most effective strategy for infection prevention in extensor reconstruction surgeries. Future studies could further explore the long-term effects of these modifications on mesh integrity and patient outcomes. This research supports the integration of antibiotic modifications as a standard practice in the preparation of synthetic meshes for surgical applications.

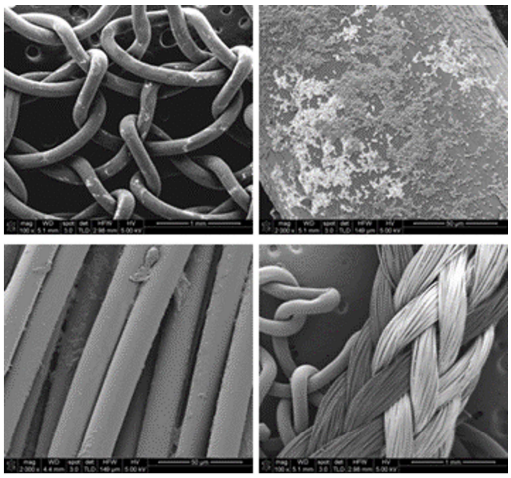

Figure1. SEM images of mesh filament (top) and suture fibers (bottom).

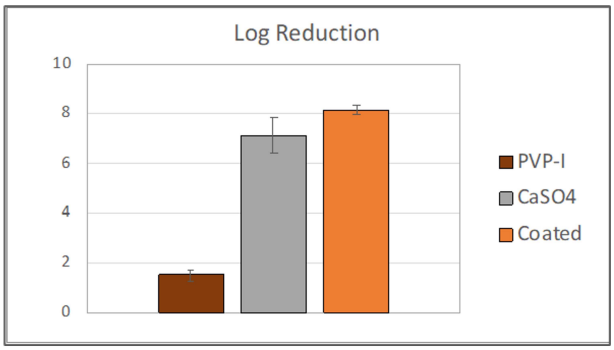

Figure2. Chart showing log reduction comparisons